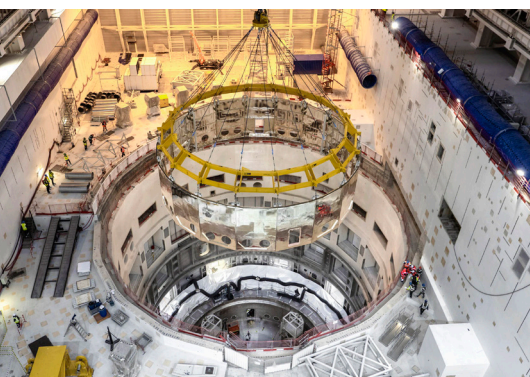


Building the Path to Fusion Energy

The ultimate goal of fusion energy is to deliver a nearly inexhaustible, carbon dioxide-free electricity source for future generations. The urgency to advance fusion energy is amplified by the projected need to reduce greenhouse emissions to zero before the middle of this century. Recent National Academies and US Department of Energy Fusion Energy Sciences reports have emphasized the need for growth in fusion technology development to prepare for a fusion pilot plant (FPP).



The 50 tonne lower cylinder of the cryostat thermal shield is lowered into the ITER tokamak pit.

Source: ITER Organization

Oak Ridge National Laboratory (ORNL) is committed to building the path to fusion energy by providing the technical basis for burning-plasma physics, next-generation materials, and fusion nuclear technology. In parallel, ORNL leads the US ITER project, providing 12 essential systems to support the operations and research of the 500 MW ITER tokamak. ORNL is also the future home of the MPEX, the Materials Plasma Exposure eXperiment, a device that will enable testing of materials designed for post-ITER reactors.

World-leading Capabilities

To generate electricity from fusion, three main challenges must be addressed: (1) creating and sustaining a fusion power source, (2) developing materials that can survive in a fusion environment, and (3) developing fusion fuel self-sufficiency with efficient technologies for harnessing fusion power. ORNL has world-leading expertise in multiple areas crucial for fusion energy development and, with access to diverse tools and experts, has established

79%

Increase in the global use of electricity by 2050

>30

public-private partnerships through INFUSE to advance fusion energy development

10

MW/m² heat flux produced by MPEX—similar to what spacecraft experience reentering Earth's atmosphere

9

global fusion facilities have installed ORNL-developed pellet technology



"Fusion is effectively trying to replicate the sun in a bottle. It's one of those world-changing things where everybody wins if we get it to work."

David Green,
Plasma Theory and Modeling Group Leader

an integrated approach to advance science and technology needed to resolve the scientific challenges associated with developing fusion energy.

- **Burning plasma**—Scientists target a wide range of required technical thrusts needed to develop the burning-plasma physics basis for ITER research, an FPP, and beyond.
- **Materials**—Scientists are creating novel materials, through traditional and advanced manufacturing techniques, for potential use in the extreme environments of future fusion reactors.
- **Computing**—Researchers are developing new codes for whole-device modeling and utilizing the Oak Ridge Leadership Computing Facility.
- **Blanket technology**—ORNL is establishing a program to lead first wall blanket development for fusion fuel and to close the fuel cycle.
- **Plasma measurement and control**—Researchers are pursuing new tools and techniques to control and measure plasmas, which are essential for optimization of fusion performance.



The ORNL-led Innovation Network for Fusion Energy program, or INFUSE, is focused on accelerating fusion energy development through research collaborations between industry and national laboratories.

infuse.ornl.gov

Impact and Collaboration

ORNL fusion delivers science and technology to enable the success of fusion devices around the world. In addition to participation in the seven-member international ITER project, ORNL engages in active collaborations with the UK Atomic Energy Authority (JET), Korea Institute of Fusion Energy (KSTAR), Max Planck Institute for Plasma Physics (Wendelstein 7-X), and the French Alternative Energies and Atomic Energy Commission (WEST). ORNL is the world leader in pellet technology used for fusion fueling and mitigation of undesired plasma modes or disruptions. In recent years, fusion devices in seven countries have installed ORNL-developed technology to improve plasma performance and control.

ORNL is also an active collaborator with the DIII-D National Fusion Facility, Princeton Plasma Physics Laboratory (PPPL), universities, and the fusion industry. The INFUSE cost-sharing program, managed by ORNL with PPPL, brings together industry with national laboratory experts to resolve fusion technology challenges. ORNL also participates in the ARPA-E GAMOW program to further the R&D of high-priority fusion technologies and systems.

Uniquely ORNL

With a long history in both fusion and fission research, ORNL brings together expertise from across nuclear systems and technologies. Fusion at ORNL benefits from experts in radiation transport and neutronics, modeling and simulation, and practical licensing and technology deployment experience. The exceptional combination of resources at ORNL, from advanced manufacturing to neutron scattering to high-performance computing, enables innovative collaborations and solutions for fusion challenges.



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